

How Does the Market Interpret Analysts' Long-term Growth Forecasts?

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July 5, 2002
(First Draft: January 2002)

The views expressed herein are those of the author and do not necessarily reflect the views of the Board nor the staff of the Federal Reserve System. I am grateful for comments and suggestions from Jason Cummins, Steve Oliner, and members of the Capital Markets Section at the Board. Excellent research assistance was provided by Eric Richards and Dimitri Paliouras.

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Abstract

The long-term growth forecasts of equity analysts do not have well-defined horizons, an ambiguity of substantial import for many applications. I propose an empirical valuation model, derived from the Campbell-Shiller dividend-price ratio model, in which the forecast horizon used by the “market” can be deduced from linear regressions. Specifically, in this model, the horizon can be inferred from the elasticity of the price-earnings ratio with respect to the long-term growth forecast. The model is estimated on industry- and sector-level portfolios of S&P 500 firms over 1983-2001. The estimated coefficients on consensus long-term growth forecasts suggest that the market applies these forecasts to an average horizon of at least 6 years, and as many as 10 years.

1. Introduction

Long-term earnings growth forecasts by equity analysts have garnered increasing attention over the last several years, both in academic and practitioner circles. For instance, among investment professionals, one of the more popular valuation yardsticks employed is the ratio of a company's PE to its expected growth. Conventionally, the denominator of this statistic is the long-term earnings growth forecast produced by analysts.

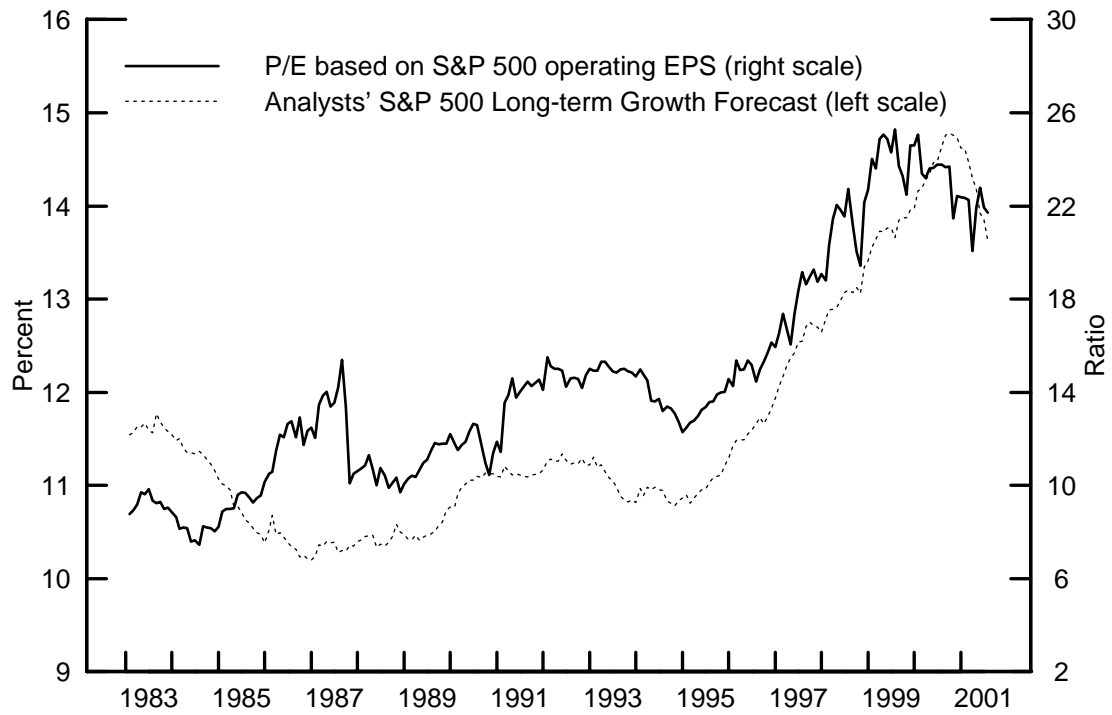
An expanding body of academic research uses equity analysts' earnings forecasts as well. One important type of application is the measurement of the equity risk premium from an ex ante perspective, though inferences from such studies can be sensitive to precisely how the long-term growth forecasts are used. Chan, Karceski and Lakonishok (2001) argue that the long-term forecasts are a "vital component" of such exercises. However, as evidenced by the range of assumptions invoked in these applications, the interpretation of these growth forecasts—the horizon to which they apply—is ambiguous. For instance, Claus and Thomas (2001), in gauging the recent level of the equity risk premium, assume these forecasts apply to the horizon from year 3 through year 5; beyond year 5 they apply a fixed growth rate assumption. At the other extreme, Harris and Marston (1992, 2001) and Khorana, Moyer and Patel (1999), apply these growth forecasts to an infinite horizon. In other studies, the assumed horizon usually falls somewhere in the middle.¹

One implication of these studies is that these long-term forecasts, or at least the views they represent, could be a key factor behind broad equity market valuations, particularly their upward drift during the second half of the 1990s. As shown in figure 1, the PE ratio for S&P500 – the ratio of the index price to 12-month-ahead earnings – rose more than 50 percent between January 1994 and January 2000. Over roughly that same time period, the weighted-average (or "bottom-up") long-term earnings growth forecast for the S&P500 climbed almost 4 percentage points to nearly 15 percent—well above previous peaks. Findings in Sharpe (2001) suggest this

¹To estimate the intrinsic value of the companies in the Dow Jones Industrials Index, Lee, Myers and Swaminathan (1999) use the long-term earnings growth rate as a proxy for expected growth only through year 3. They implicitly pin down earnings growth beyond that point by assuming that the rate of return on equity reverts toward the industry median over time. Gebhardt, Lee and Swaminathan (2001) also use this formulation.

Figure 1

Forward Price-Earnings Ratios versus Analysts' Long-term Growth Forecast for S&P 500



was no coincidence, that Wall Street's long-term growth forecasts have been a significant factor in valuations; however, because of their relatively short history and high autocorrelation, the size of that influence remains uncertain.

In this study, I attempt to gauge the appropriate horizon over which to apply the growth forecast by appealing to the market's judgement, that is, by inferring it from market prices. In particular, I propose a straightforward empirical valuation model in which linear regression analysis can be used to deduce the forecast horizon the "market" uses to value stocks. This model is a descendent of the Campbell and Shiller (1988, 1989) dividend-price ratio model and an approximation to the standard dividend-discount formula. As in Sharpe (2001), their model is modified so as to emphasize the expected dynamics of earnings, rather than dividends. In the resulting framework, the horizon over which the market applies the growth forecast can be inferred from the elasticity of the price-earnings ratio with respect to the long-term growth forecast.

I estimate the model using industry- and sector-level portfolios of S&P 500 firms, constructed from quarterly data on stock prices and consensus firm-level earnings forecasts over 1983-2001. The estimated coefficients on consensus long-term growth forecasts suggest that the market applies these forecasts to an average horizon somewhere in the range of 6 to 9 years. Thus, these projections are more important for valuation than assumed in the many applications that treat them more literally as 3 to 5 year forecasts but significantly less influential than forecasts of growth into perpetuity. Among other implications, the results imply that the increase in S&P500 company growth forecasts during the second half of the 1990s can explain about half of the attendant rise in the PE ratio for that index.

2. The Relation Between PE Ratios, Expected EPS Growth, and Payout Rates

2.1 The Basic Idea

The principal modeling goal is to develop to a simple estimable model of the relationship between the price-earnings ratio and expected earnings growth. As discussed in the subsequent section, by expanding out terms in the model of Campbell and Shiller (1988), we can produce the following relation for any equity or portfolio of equities:

$$\log \frac{P_t}{EPS_{t+1}} \approx \sum_{j=2}^{\infty} \rho^{j-1} g_{t+j} + Z_t \quad (1)$$

where P_t is the current stock price, EPS_{t+1} is expected earnings per share in the year ahead, g_{t+j} is expected growth in earnings per share in year $t+j$. ρ is a constant slightly less than 1, similar to a discount factor, and Z_t is a function of the expected dividend payout rates and the required return.

For the analysis that follows, divide the discounted sum of expected EPS growth rates into two pieces:

$$\sum_{j=2}^{\infty} \rho^{j-1} g_{t+j} = \sum_{j=2}^T \rho^{j-1} g_t^L + \sum_{j=T+1}^{\infty} \rho^{j-1} g^{\infty} \quad (2)$$

where g_t^L represents the expected average EPS growth rate over the next T years, measured by analysts' long-term growth forecasts, and g^{∞} is the average growth rate expected thereafter. This amounts to assuming there is a finite horizon, T , over which investors formulate their forecasts of earnings growth; beyond that horizon, expected average growth (g^{∞}) is assumed constant or, at a minimum, uncorrelated with g^L .

We thus rewrite (1) as follows:

$$\log \frac{P_t}{EPS_{t+1}} = \frac{\rho(1-\rho^{T-1})}{1-\rho} g_t^L + Z_{0t}(T) \quad (3)$$

where $\frac{\rho(1-\rho^{T-1})}{1-\rho} = [\rho + \rho^2 + \rho^3 + \dots + \rho^{T-1}]$ and $Z(T)$ now subsumes an additional (independent) term containing the growth rate expected after T . Clearly, the longer the horizon over which investors' formulate "long-term" growth forecasts, the larger will be the "effect" on stock prices of any change in that expected (average) growth rate. For instance, suppose $\rho=0.96$; if investors apply the forecast on a horizon running between year 1 through year 5 (growth in year 2, 3, 4, and 5) the multiplier on g^L is 3.6. If, instead, this horizon ran from year 1 through year 10, the multiplier would be 7.4. The main contribution of this paper is to infer this horizon by estimating this multiplier--the elasticity of the PE ratio with respect to the expected growth rate--in the context of the valuation model described more thoroughly below.

2.2 Derivation of the Empirical Model

Campbell and Shiller (1988) show that the log of the dividend-price ratio of a stock can be expressed as a linear function of forecasted one-period rates of return and forecasted one-period dividend growth rates; that is,

$$\log \frac{D_t}{P_t} = E_t \left[\sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} - \sum_{j=1}^{\infty} \rho^{j-1} \Delta d_{t+j} \right] + k \quad (4)$$

where D_t is dividends per share in the period ending at time t and P_t is the price of the stock at t . On the right hand side, E_t denotes investor expectations taken at time t , r_{t+j} is the return during period $t+j$, and Δd_{t+j} is dividend growth in $t+j$, calculated as the change in the log of dividends. The ρ is a constant less than unity, and can be thought of as a pseudo-discount factor.

Campbell-Shiller show that ρ is best approximated by the average value over the sample period of the ratio of the share price to the sum of the share price and the per share dividend, or $P_t / (P_t + D_t)$. k is a constant that ensures the approximation holds exactly in the steady-state growth case. In that special case, where the expected rate of return and the dividend growth rate are constant, equation (4) collapses to the Gordon growth model: $D_t / P_t = R - G$.

The Campbell-Shiller dynamic growth model is convenient because it facilitates the use of linear regression for testing hypotheses. As pointed out by Nelson (1999), the Campbell Shiller dividend-price ratio model can be reformulated by breaking the log dividends per share term into the sum of two terms--the log of the earnings per share and the log of the dividend payout rate. When this is done and terms are rearranged, then the Campbell-Shiller formulation can be rewritten as:

$$\log \frac{EPS_t}{P_t} = E_t \left[\sum_{j=1}^{\infty} \rho^{j-1} r_{t+j} - \sum_{j=1}^{\infty} \rho^{j-1} g_{t+j} - (1-\rho) \sum_{j=1}^{\infty} \rho^{j-1} \phi_{t+j} \right] + k \quad (5)$$

where EPS_t represents earnings per share in the period ending at t , $g_{t+j} = \Delta \log EPS_{t+j}$, or log earnings per share growth in $t+j$, and $\phi_{t+j} = \log(D_{t+j}/EPS_{t+j})$, the log of the dividend payout rate in

$t+j$.

This reformulation is particularly convenient as it facilitates a focus on earnings growth. To simplify and further focus data requirements on earnings forecasts (as opposed to dividend forecasts), I assume that the expected path of the payout ratio can be characterized by a simple dynamic process. In particular, reflecting the historical tendency of payout ratios to revert back toward their target levels subsequent to significant departures, I assume that investors forecast the (log) dividend payout ratio as a stationary first-order autoregressive process:

$$E_t \phi_{t+j} = \lambda \phi^* + (1 - \lambda) \phi_{t+j-1} \quad (6)$$

In words, the payout rate is expected to adjust toward some norm, ϕ^* , at speed $\lambda < 1$.

It is straightforward to show that, given (6), the discounted sum of expected log payout ratios in (5) can be written as a linear function of the current payout rate:

$$E_t \sum_{j=1}^{\infty} \rho^{j-1} \phi_{t+j} = \frac{1 - \lambda}{1 - \rho(1 - \lambda)} \phi_t + \frac{\lambda/(1 - \rho)}{1 - \rho(1 - \lambda)} \phi^* \quad (7)$$

The final equation is arrived at by substituting into (5) the assumed structure of expected payout rates (7), and the assumed structure of earnings growth forecasts (2). Rearranging terms, and defining R_t as the discounted sum of expected returns:

$$\log \frac{P_t}{EPS_{t+1}} = \frac{\rho(1 - \rho^{T-1})}{1 - \rho} g_t^L + \alpha \phi_t + \left[\frac{\rho^{T+1}}{1 - \rho} g^\infty + (1 - \alpha) \phi^* \right] - R_t + k \quad (8)$$

where $\alpha = \frac{(1 - \rho)(1 - \lambda)}{1 - \rho(1 - \lambda)}$ is between 0 and 1.

2.3 Empirical Implementation

To translate equation (8) into a regression equation with the PE ratio as dependent variable, note that the first pair of right-hand side variables--the long-term growth forecast (g^L) and the current log dividend payout rate (ϕ)--are observable, at least by proxy. The pair of terms

in brackets are the expected “long-run” log payout ratio and expected earnings growth in the “out years,” both of which are unobservable and assumed constant; thus, they are absorbed into the regression constant. Even if constant over time, they are likely to vary cross-sectionally, which suggests the need for additional controls or industry dummies. Finally, expected future returns, R_{it} , are also unobservable. To control for time variation in expected returns, macroeconomic factors are added to the list of regressors. As discussed below, cross-sectional variation in expected returns is dealt with by including fixed effects.

Letting i represent a firm or portfolio of firms, and letting Z represent proxies for, or factors in, expected returns, (8) is translated into the following regression equation:

$$\log \frac{P_{it}}{EPS_{i,t+1}} = \beta g_{it}^L + \alpha \phi_{it} + \beta_{0i} - \gamma Z_{it} + u_{it} \quad (9)$$

with u_{it} a mean-zero error term, assumed to be uncorrelated with the explanatory variables.

Given an assumed value for ρ , the horizon over which investors apply analysts’ long-term growth forecasts can be inferred from the magnitude of β , which should be positive. For these calculations I assume $\rho=0.96$; in that case, if long-term growth horizon applied to the five years of growth beginning at the end of the current year ($T=6$), we would expect the coefficient on long-term growth to be 4.4 . The resultant mapping from horizon T to implied coefficient is provided in the following table:

T	2	3	4	5	6	8	10	20	∞
β	0.96	1.9	2.8	3.6	4.4	6.0	7.4	12.9	24

To understand why the best approximation for ρ is $\frac{P}{P+D}$, consider the case where g is the expected growth into perpetuity ($T=\infty$). In this case, the coefficient on g , according to (8), would boil down to simply $\rho/(1-\rho) = P/D$. But this is precisely the implied effect of growth on price in the Gordon (constant) growth model; in that model, $\frac{\partial \log P}{\partial g} = \frac{1}{r-g} = \frac{P}{D}$. Moreover, as long as the horizon is not extremely distant -- the coefficient on g^L is not too large -- then the

inferred horizon is not very sensitive to the precise choice of ρ .²

According to the model (8), the coefficient on the dividend payout rate should lie between 0 and 1. It would equal 1 if the current payout rate was expected to be maintained forever ($\lambda=0$); in most cases it should be much closer to zero than 1, even if the dividend payout rate is expected to revert quite slowly back to the long-run payout rate. For instance, if $\lambda=0.1$ (the payout rate is adjusted annually by 10 percent of the gap between the desired and current level), then the theoretical coefficient on the payout rate (given $\rho=.96$) would be 0.27.

Clearly, the assumed dynamics of the payout rate are a simplification. It is quite plausible, for instance, that the long-run target for any given industry evolves over time. If that were the case, then we would expect the current payout rate to carry more information about the average future payout; thus, its coefficient would be larger than that what is implied by short-run autocorrelations, and we would interpret it somewhat differently. However, this would not alter our interpretation of the coefficient on the growth forecast. Indeed, excluding the payout rate from the regression or adding another lag does not substantially alter inferences drawn with regard to the growth horizon.

As in much of the research on expected returns, estimation is conducted on portfolios of firms. One potential benefit of this aggregation is a reduction in potential measurement error that comes from using analysts' forecasts as proxies for long-term growth forecasts. But using portfolios is also necessary because model (8) cannot be applied literally to firms that do not have positive dividends and earnings because the log payout ratio would be undefined. The model is too stylized for application to very immature firms. To some extent, this observation guides the choice of portfolio groupings. In particular, firms are grouped into portfolios by industry, rather than by characteristics that would be correlated with firm size or maturity.

3. Data and Sample Description

3.1 The data

The sample is constructed using monthly survey data on equity analyst earnings forecasts

²For instance, if $T=6$, then the coefficient (β) is predicted to be 4.3 for $\rho=0.95$ versus 4.6 for $\rho=0.97$.

and historical annual operating earnings, both obtained from I/B/E/S International. A dataset of quarterly stock prices and earnings forecasts is constructed using the observations from the middle month of each quarter (February, May, August, and November), beginning in 1983, when long-term growth forecasts first become widely available in the I/B/E/S database. The sample in each quarter is built using firms belonging to the S&P500 at the time. Sample firms must also have consensus forecasts for earnings per share in the current fiscal year (EPS1) and the following fiscal year (EPS2), as well as a consensus long-term growth forecast. Data on dividends per share are mostly drawn from the historical I/B/E/S tape, though missing values in the early part of the sample are filled in using Compustat.

The data of greatest interest in this study are the equity analysts' long-term growth forecasts, which I measure using the median analyst forecast from I/B/E/S, where the typical forecast represents the "expected annual increase in operating earnings over the company's next full business cycle." In general, these forecasts refer to a period of between three to five years (I/B/E/S International, 1999). Clearly, this description is fairly ambiguous about the horizon of these forecasts, though three to five years is probably the most widely cited horizon.

The measure of expected earnings used for the denominator of the PE ratio is constructed using forecasts for both current-year and next-year earnings. For any given observation, a firm's "12-month-ahead" earnings per share $EPS_t = w_m * EPS1 + (1 - w_m) * EPS2$, where the weight (w_m) placed on current year EPS is determined by the fraction of the current year that remains. For instance, w_m is 1 if the firm just reported its previous fiscal-year earnings within the previous month, and it equals 11/12 if the firm reported its previous year's earnings 1 month ago. The PE ratio is then calculated as the ratio of current price to 12-month-ahead earnings.

To construct the lagged dividend payout ratio, I create an analogous measure of 12-month *lagging* earnings. Specifically; 12-month lagging earnings, or $EPS_{t-1} = w_m * EPS0 + (1 - w_m) * EPS1$, where $EPS0$ is earnings per share reported for the previous fiscal year. The dividend payout rate is then calculated as the ratio of the firm's most recent (annualized) dividend per share to its 12-month lagging operating earnings per share. Prior to 1985, the dividend variable is not provided in the I/B/E/S data. For these observations, the dividend per share value is taken from Compustat.

3.2 Construction of Sector and Industry Portfolios

For each quarterly observation, firms are grouped into portfolios using two alternative levels of aggregation. In the more aggregated case, firms are grouped into 11 sectors, which are broad economic groupings as defined by I/B/E/S (Consumer Services, Technology, ...etc.). The second portfolio grouping is comprised of industry-level portfolios, constructed using I/B/E/S industry codes that are similar in detail to the old 2-digit Standard Industrial Classification (SIC) industry groupings. For instance, the technology sector is broken down into (i) computer manufacturers, (ii) semiconductors and components, (iii) software and EDP services, and (iv) office and communication equipment.

Each quarterly observation for each variable is constructed by aggregating over all portfolio members in that quarter--S&P500 firms in the given sector (or industry). Constructing a portfolio aggregate long-term growth forecast is somewhat tricky because these variables are growth rates and because there is no clearly optimal set of weights for aggregating these growth rates. The most intuitive choice would be the level of a firm's previous-year earnings; but this would be nonsensical in the case where some firms had negative earnings. To get around this, I use expected earnings. Specifically, a firm's weight is calculated as current shares times the maximum of $[EPS1, EPS2, 0]$. This avoids the problem of potentially negative weights; it also minimizes the number of companies with zero weight because $EPS2$ is almost always positive for S&P500 firms.

The dependent variable, the price-earnings ratio, is constructed by summing up the market values of all (S&P500) sector or industry members, and then dividing by the sum of their expected 12-month ahead earnings, or expected earnings per share times shares outstanding. Similarly, dividend payout rates at the portfolio level are constructed by summing the dividends (dividends per share times shares outstanding) of portfolio members and dividing by the sum of their 12-month lagging earnings.

The payout rate or the PE ratio is undefined when their denominator is negative; thus, these variables are occasionally undefined for the finer industry-level portfolio partition. Moreover, there is a higher frequency of negative observations on 12-month lagging earnings

than on 12-month ahead earnings (owing mostly to analysts' optimistic bias); that is, actual earnings are negative more often than expected earnings. To reduce the loss of industry-level observations as a result of negative earnings, in constructing industry payout ratios, I substituted an industry's 12-month ahead earnings for its 12-month lagging earnings in cases where the latter is negative and the former is not, though this has little effect on the results.

3.3 Controls for expected returns

Because empirical inferences are partly drawn from the time series dimension of the data, I include proxies for the expected long-run return on the market portfolio, specifically the long-term (10-year) government bond yield and the risk spread on corporate bonds, or the difference between the yields on the Moody's Aaa and Baa corporate bond indexes. In light of the findings of Fama and French (1989) and others, that *excess* expected equity returns are positively related to the risk spread between corporate and government bonds, we expect the PE ratio to be negatively related to the corporate risk spread.

A third macro factor I consider is the expected inflation rate, as proxied by the four-quarter expected inflation rate from the Philadelphia Federal Reserve survey of professional forecasters. As suggested in Sharpe (2001), expected inflation also appears to be a positive factor in required equity returns (before taxes), perhaps because inflation raises the effective tax rate on real equity returns.

I do not construct a measure of the industry or sector portfolio betas, or any other cross-sectional determinants of expected returns. To begin with, the bulk of empirical research weighs in on the side of finding very little role for beta. Perhaps most salient is Gebhardt, Lee, and Swaminathan (2001), which also studies expected returns using an earnings-based *ex ante* measure. They find beta to be of little value in explaining cross-sectional differences in expected return. On the other hand, their findings suggest that industry membership is a factor in expected returns; I control for potential industry factors in expected returns by including fixed industry effects.³

³Indeed, Gebhardt, et. al find the long-term growth forecast to be a positive factor in firm-level expected returns. But that finding might be the result of assumptions they use to construct their *ex ante*

Of course, it is possible that required returns are positively related to expected growth, as high growth firms or industries are more risky. In that case, this would result in a second channel through which expected growth would have a negative effect on PE ratios, and there would be little hope of identification. In this case, we would have to interpret our regressions as providing a lower bound on the horizon to which investors apply growth forecasts. That is, if higher returns are required on higher growth firms, *ceteris paribus*, we will underestimate the positive effect of the long-term growth forecast that arises from its role as a measure of expected earnings growth.

3.4 Sample Statistics

After dropping the first observation per sector or industry in order to create one lag on the PE ratio, the sample runs from 1983:Q2 to 2001:Q2. This leaves a potential of 73 quarterly observations for each of 11 sectors, or 803 sector-time observations. In addition to excluding observations for which earnings are negative or dividends are zero, those with extreme values are also filtered out. In particular, observations are excluded if either the portfolio PE ratio exceeds 300 or its dividend payout rate exceeds 5.

In the case of sector portfolios, these filters remove only 2 observations; and no observations are lost as a result of negative earnings or zero dividends. Distributions of the key variables for the sector portfolios are depicted by the top number among each pair of numbers in table 1. The average sector price-earnings ratio over the sample period is about 14, and it ranges from 3.5 to 54.1. The average dividend payout rate is 0.45 (or 45 percent of earnings), with a range of 0.08 to 2.16. The average expected long-term growth rate is 11 percent, with a range of 5 to 20 percent.

Correlations among variables are shown in the bottom half of the table. The PE ratio is

measure of expected return. If their measure builds in too long a horizon on the growth forecast, then the growth forecast will appear to have a positive effect on expected return (or a negative effect on valuations). In their “terminal value” calculation, the slow decay rate of ROE, and the use of median industry ROE as the expected ROE for perpetuity, may implicitly build in too long a horizon on current expected earnings growth or, more precisely, on the value of ROE in year $t+4$. Indeed, it is somewhat curious that long-term growth is a significant factor in expected return only when the regression also includes the book-to-market ratio—another key component in the construction of the dependent variable.

strongly correlated with the earnings growth forecast, as theory would suggest, but it is uncorrelated with the dividend payout rate. The earnings growth forecast is negatively correlated with the dividend payout rate, consistent with the prediction that firms with lower growth prospects pay out a higher proportion of their dividends.

In the case of industry portfolios, roughly 120 observations are excluded where industry dividends are zero or, in a handful of cases, where expected year-ahead earnings are negative, leaving 4071 observations on 66 industries.⁴ Another 14 observations are excluded because the PE ratio exceeds 300 or the dividend payout rate exceeds 5, leaving 4057 industry-quarter observations, an average of about 62 quarters per industry. Distributions and correlations for the industry portfolio variables are depicted by the bottom figures among the pairs in table 1.

4. Regression Results

Table 2 shows the results of sector portfolio regressions with the log of the PE ratio as dependent variable. Heteroskedasticity and autocorrelation-consistent (Newey-West) standard errors are reported below the coefficient estimates. Column (1) shows the simplest specification; it includes the earnings growth forecast, the sector payout rate, the yield on the 10-year Treasury bond, and the risk spread on corporate bonds. The coefficient estimate on the growth forecast is 8.05, with a standard error of 0.5, indicating relatively high precision. The magnitude of the coefficient suggests that growth forecasts reflect expectations over a fairly long horizon. In particular, given that $\frac{\rho(1-\rho^{T-1})}{1-\rho}$ equals 7.75 for T=10 and 8.5 for T=11, the inference would be that the long-term growth forecast represents the expected growth rate for a 9 or 10 year period, starting from the coming year's expected level of earnings.

The coefficient on the payout rate, 0.34, falls within the [0,1] range dictated by theory; but, interpreted literally, the magnitude of the coefficient implies that payout rates adjust very slowly toward their long-run desired level. Interpreted more loosely, one could infer that the current payout rate also conveys some information about a sector's long-run desired payout rate,

⁴I have also excluded 5 very small industries for which the average total industry market value (over the sample period) is less than \$1 billion. Also note that not all industries exist over the entire sample.

which is not likely to be constant over the very long run as assumed in the model.

The coefficients on the bond yield and the risk spread are both negative, as theory and previous empirical results would predict. The coefficient on the Treasury bond yield implies that a one percentage point increase in long-term yields drives down the PE ratio—or the stock price holding E constant—about 12 percent. The regression R-squared is quite high, suggesting these four variables explain about 70 percent of the overall cross-sectional and time series variation in price-earnings ratios. The root mean squared error is 0.2.

One problem with this specification, however, is the presence of strong autocorrelation in the errors, reflected in a Durbin-Watson statistic of 0.32. In specification (2), this is rectified by modeling the dynamics with the addition of a lagged dependent variable. In this regression, the lagged PE ratio receives a coefficient of 0.75 and is highly significant. Adding this regressor also raises the R-squared to 0.910 and cuts the root mean squared error in half; moreover, the Durbin-h test now strongly rejects the presence of autocorrelation.

Interpreting the coefficient on the growth forecast is a bit more complicated here because that coefficient, equal to 2.00, now represents only the “impact effect”. The total long-run effect of a change in the growth forecast is equal to the impact coefficient divided by one minus the coefficient on the lagged PE, or $2/(1-0.75) = 8$. Thus, the conclusion from the original regression holds up: the growth forecast still appears to represent a horizon of about 9 years.

The long-run effect of the payout rate is 0.28, only a bit smaller than the static estimate. One notable difference from the static model is that the sign on the risk spread flips to positive, although that variable is no longer statistically significant. Thus, once we account for growth expectations and the underlying dynamics, the risk spread no longer has marginal explanatory power for stock valuations.

The third and fourth specifications address a potential omitted variable problem. Gebhardt, et. al (2001) find sector-level factors in expected returns. If these factors are correlated with a sector’s average long-term growth expectation, then the coefficient on growth forecasts will be biased. Sector-level expected-return factors can be removed using a fixed effects estimator. In column (3), results are shown for the static version of the model estimated on sector-mean-adjusted variables; and, in (4), results are shown when fixed effects are similarly

incorporated into the dynamic model. In both cases, the results continue to yield similar conclusions.⁵

Finally, I consider the possibility that omitted macroeconomic factors in expected returns are correlated with changes in the average sector growth forecast over time. Column (5) shows the results from adding expected inflation, specifically, expected inflation over the next four quarters as measured by the Philadelphia Fed survey of professional forecasters. As shown by Sharpe (2001), expected inflation seems to be related to both expected earnings growth and expected returns. In addition, controlling for expected inflation allows us to interpret the estimated effect of changes in expected long-term growth as a reflection of changes in real growth expectations. In any case, the result from adding expected inflation to the dynamic specification is a somewhat smaller estimate of the effect of expected growth. The long-run effect of 6.63 is now consistent with a horizon between 7 and 8 years.

The final specification takes a more agnostic approach to macro factors and adds year dummies (in addition to the fixed sector effects). This eliminates any effect of the growth forecast that might be purely time-driven, and thus provides the most conservative estimate of the effect of these earnings expectations. Indeed, the long-run coefficient on the growth forecast falls to 5.45 in this regression, which suggests a horizon of about 6 years. Considering the totality of the findings in table 2, one would conclude that the horizon of the earnings growth forecast falls somewhere in the range of 6 to 10 years.

An analogous set of results based on narrower industry-level portfolios is shown in table 3. The industry-level results generally follow the pattern of the sector-portfolio results, with one important difference. In these regressions, the long-run coefficient on the growth forecast tends to be about two-thirds the magnitude found in the analogous sector-level regressions. In particular, the coefficient estimate on the growth forecast runs from 5.4 in the specifications without fixed effects down to 3.9 in the specification with both fixed industry and time effects. These results would suggest that investors apply the growth forecast to a horizon somewhere between 4 to 7 years, compared to the 6 to 10 year range suggested by the sector-level analysis.

⁵Given the sample size, the small sample bias that arises when a lagged dependent variable is used in conjunction with fixed effects should not be an issue.

One interpretation of these findings is that the growth forecast measures investor expectations with error. Under the presumption that measurement error on other regressors, namely the payout rate, is minimal, measurement error in the growth forecast would cause its coefficient to be downward biased. Moreover, if such measurement errors were not highly correlated across the firms or industries in a given sector, then using a higher level of aggregation would tend to reduce the variance of the measurement error. A similar, perhaps more structural, explanation would be that investor expectations for a firm's or industry's growth beyond the next few years is partially reflected in growth expectations for other firms or industries within the same broad sector. Under either interpretation, one would expect the PE of an industry portfolio to be positively related to the growth forecast not only for that industry but also to forecasts for other industries in the same sector.

This hypothesis can be examined by estimating the industry regressions (like those shown in table 3) with the sector growth forecast as an additional explanatory variable. With both the industry and sector growth forecast in the regression, one can interpret the sum of the two coefficients on the sector and industry growth forecasts as measuring the total effect of an increase in expected industry growth that is matched by an equal-sized increase in expected sector-level growth. For instance, when the sector growth forecast is added to specification (4), the long-run coefficients on industry and sector growth forecasts are estimated to be 3.62 and 3.40, respectively. Thus, sector growth expectations help explain industry valuations. These sum to a total effect of 7.02, closer to the 7.92 growth forecast coefficient in the sector regression than the 4.53 in the industry regression.⁶ Reestimating (6) yields long-run coefficients on industry and sector growth forecasts equal to 3.50 and 1.66, respectively; these sum to 5.16, only slightly below the respective sector level estimates.

5. Summary and Implications

The analysis above strongly confirms the value-relevance of analysts' long-term earnings

⁶An alternative tack, which amounts to the same test, would be to put the industry growth forecast and, second, the differential between the sector and industry growth forecasts in the regression. In this case, the coefficient on the industry growth forecast would be 7.02, and the coefficient on the differential would be 3.4.

growth forecasts for valuations, and suggests an applicable horizon of at least 6 years, and perhaps up to 10 years, consistent with regression coefficients between 5 and 8. In other words, regression estimates suggest that a 1 percentage point increase in expected earnings growth can explain a 5 to 8 percent boost in an industry's PE ratio. Given the 4 point rise in the "bottom-up" S&P500 growth forecast documented in figure 1, the analysis thus suggests that higher long-term growth expectations can account for a 20 and 32 percent rise in the market PE, or around half the increase during the latter half of the 1990s.

The relation between equity valuations and long-term growth forecasts suggests that investors view such forecasts as a strong indication of growth prospects for at least six or seven years. It would thus appear that the market places a great deal of faith in the ability of analysts to divine differences in firm or industry long-term prospects. Of course, this begs the question: what is the nature of the relationship between predicted and realized long-term earnings growth? An analysis of this issue is beyond the scope of this study, but recent research offers at least a partial answer.

Most previous studies of the properties of analyst forecasts suggest that analysts' shorter term forecasts, while quite informative, violate rational expectations; but, until recently, the properties of long-term growth forecasts had received less attention. One clear finding of the recent research is that long-term forecasts are both upward biased and extreme; that is, the higher a growth forecast is, the more upward biased it tends to be [Dechow and Sloan (1997), Rajan and Servaes (1997)]. There is mixed support for the view that analysts over-extrapolate from recent observations [De Bondt (1992), La Porta (1996)].

If the weight placed on these forecasts overreaches the ability of analysts (and perhaps anyone else) to predict long-run performance, one would expect them to be contrary indicators of future stock performance. Indeed, the studies mentioned above find that stocks of firms with high long-term growth forecasts tend to produce substandard returns. In an analysis of long-term growth forecasts issued during 1982-1984, De Bondt (1992) finds a significant inverse relation between expected growth and excess returns over the subsequent 12-18 months. La Porta's (1996) analysis of forecasts made during 1982-1991 finds annual (cross-sectional) stock returns to be negatively related to beginning-of-period long-term growth forecasts, and Rajan and

Servaes (1997) find the same for in the case of post-offering performance of IPO stocks. More specifically, Dechow, Hutton and Sloan (1999) estimates a relation between the five-year performance of IPOs and the size of the realized error in these growth forecasts.

Finally, Chan, Karceski and Lakonishok (2001) offer some very interesting statistics related to the efficacy of long-term growth forecasts. Perhaps their most telling findings come from a quantitative comparison of realized with predicted growth for firms sorted into quintile portfolios according to their I/B/E/S long-term growth forecast each year. Averaged over their sixteen year sample, the median (growth rate) forecasts in the top and bottom quintiles are 22.4 percent and 6 percent, respectively, an average spread of 16-1/2 percentage points. They compare this spread with the difference in growth rates observed in subsequent years. One can infer from their results that, from year 2 through 5, the median realized growth rates in operating income for the top and bottom quintiles differ by only 5-1/2 percentage points, or one-third of the forecasted growth differential.⁷

My model estimates suggest that industry portfolios are valued as if the market believes the entire differential in long-term growth forecasts ought to be applied to a six-year horizon or longer. Another legitimate interpretation of my regression estimates would be that investors (correctly) view only one-third of the forecasted differential as credible, but apply that smaller differential over a much longer horizon. However, to justify the coefficient magnitudes, investors would have to expect this reduced differential to persist for at least 20 years. While not out of the question, this would seem to be a tough hurdle, and certainly seems to be contradicted by the other main finding in Chan, et al. (2001)--when firms are ranked by income growth, such rankings show very little persistence.

As with the evidence on stock returns, the findings of Chan, et al., are largely focused on the cross-sectional informativeness of growth forecasts. Thus, the efficacy of the time-series information in long-term growth forecasts, measured by changes in such forecasts for firms or

⁷They find that, in the first year after the forecast, median realized growth in operating income for those quintiles was 16 percent and 3-1/2 percent, a spread of 12-1/2 percentage points, about three-fourths of the expected spread. But the spread in median realized growth narrows to 7 points when the performance period is extended to 5 years. Backing out the strong contribution from the first year yields an implied average growth differential in the subsequent four years (years 2-5) of about 5-1/2 percent.

industries, should thus be an important direction for future research.

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Table 1

Sample Statistics for Sector Portfolios (top) and Industry Portfolios (bottom)

	Mean	Std. Dev	Min	Max
P/E	14.2	5.8	3.5	54.1
	14.9	7.5	3.0	127.3
Payout	0.45	0.20	0.08	2.2
	0.41	0.28	0.01	4.1
Growth	11.2	0.03	0.05	0.20
	14.9	0.03	0.03	0.27

Pearson Correlation Coefficients

	P/E	Payout
Payout	0.02	1.00
	0.15	1.00
Growth	0.45	-0.44
	0.30	-0.33

The samples runs quarterly from 1983:Q2 to 2001:Q2. In the more aggregated portfolios, there are 801 observations on 11 sectors; the second sample has 4071 observations on 66 industries.

Table 2
Sector Portfolio Regressions: Dependent variable is the sector-level log PE ratio*

	(1)	(2)	(3)	(4)	(5)	(6)
Growth (β)	8.05 (0.50)	2.00 (0.55)	9.69 (1.05)	2.66 (0.77)	2.30 (0.70)	1.69 (0.70)
$\beta/(1-\lambda)$		8.00		7.92	6.63	5.45
Payout Rate	0.34 (0.05)	0.07 (0.03)	0.31 (0.08)	0.07 (0.04)	0.09 (0.04)	0.09 (0.04)
10-Year Treasury Yield	-11.99 (0.63)	-3.99 (0.78)	-11.84 (0.52)	-4.73 (0.67)	-2.86 (0.57)	
Risk Spread	-9.90 (4.02)	3.41 (1.92)	-8.82 (3.27)	2.84 (1.78)		
Expected. Inflation					-5.18 (1.04)	
Lagged PE (λ)		0.75 (0.06)		0.67 (0.05)	0.65 (0.05)	0.69 (0.06)
Adj. R-Squared	.706	.910	.714	.889	.893	.764
Root MSE	.204	.113	.172	.107	.106	.085

*801 sector-time observations on 11 sectors over 1983:Q2 to 2001:Q2. Specifications (1) and (2) are estimated with OLS; fixed industry effects are added in (3)-(6) by using OLS on industry mean-adjusted values; year dummies are added in (6). Newey-West robust standard errors are shown in parentheses. Below the standard error for the coefficient on *Growth* (long-term growth) in (2), (4)-(6) is the implied “long-run” effect of *Growth* – equal to the coefficient on growth divided by $(1-\lambda)$, where λ is the coefficient on the lagged PE.

Table 3
Industry Portfolio Regressions: Dependent variable is the industry-level log PE ratio*

	(1)	(2)	(3)	(4)	(5)	(6)
Growth (β)	5.39 (0.37)	0.91 (0.16)	5.06 (0.36)	1.36 (0.21)	1.20 (0.20)	1.00 (0.22)
$\beta/(1-\lambda)$		5.45		4.53	3.96	3.88
Payout Rate	0.15 (0.02)	0.04 (0.01)	0.20 (0.02)	0.07 (0.01)	0.08 (0.01)	0.07 (0.01)
10-Year Treasury Yield	-10.59 (0.54)	-2.87 (0.27)	-10.33 (0.38)	-3.98 (0.28)	-2.38 (0.30)	
Risk Spread	-5.93 (3.33)	4.36 (1.30)	-6.83 (2.13)	2.26 (1.31)		
Expected Inflation					-3.96 (0.67)	
Lagged PE (λ)		0.83 (0.02)		0.71 (0.02)	0.70 (0.02)	0.74 (0.03)
Adj. R-Squared	.421	.857	.510	.792	.794	.699
Root MSE	.311	.155	.226	.147	.146	.12

*4057 industry-time observations on 66 industries over 1983:Q2-2001:Q2. Specifications (1) and (2) are estimated with OLS; fixed industry effects are added to (3)-(6), by using OLS on industry mean-adjusted values; year dummies are added in (6). Newey-West robust standard errors are shown in parentheses. Below the standard error for the coefficient on *Growth* (long-term growth) in (2), (4)-(6) is the implied “long-run” effect of *Growth* – equal to the coefficient on growth divided by $(1-\lambda)$, where λ is the coefficient on the lagged PE.